

# DSIAC TECHNICAL INQUIRY RESPONSE

## Comparison of GoPro Karma and DJI Mavic Pro Compact Drone Systems

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DSIAC is a Department of Defense Information Analysis Center

**MAIN OFFICE**

4695 Millennium Drive

Belcamp, MD 21017-1505

Office: 443-360-4600

Email: [ted.welsh@dsiac.org](mailto:ted.welsh@dsiac.org)

**Report Prepared by:**

Scott Armistead

1819 Lewis Turner Boulevard

Fort Walton Beach, FL 32547

Office: 850-362-6920

Email: [scott.armistead@dsiac.org](mailto:scott.armistead@dsiac.org)

## 1.0 Technical Inquiry Background

1.1 **Requesting Organization:** Defense Systems Information Analysis Center (DSIAC)

1.2 **Subject:** Request information on recently released COTS turnkey “backpackable” drone systems with 4K video capture capability.

1.3 **Additional Details:** Commercial OEMs are beginning to release highly capable drone systems that can be collapsed to fit in a small backpack. These systems offer stabilized 4K video capture systems along with significant improvements with respect to size, weight and power (SWaP) as well as other advanced capabilities such as automated target tracking and collision avoidance.

## 2.0 Response

DSIAC staff searched open sources and found that during September 2016, two well-known COTS manufacturers, SZ Dà-Jiāng Innovations Science and Technology Co., Ltd (DJI), Shenzhen, Guangdong China, and GoPro, Inc., San Mateo, CA, released or announced pending release of small foldable drone systems capable of 4K video capture.

### 2.1 GoPro Karma

The Karma drone platform is somewhat larger and heavier than the DJI Mavic Pro. It has a GPS based positioning and navigation system, a 3-axis stabilized gimbal system that use the company’s Hero camera line of products, and is capable of up to 4K video capture using a 1/2.3” CMOS sensor based camera. Gimbal range of motion is -90 to +0 degrees.

The system’s 5,100 mAH LiPo based power pack is capable of providing up to 20 minutes of flight time and a maximum travel distance of approximately 6 mi during a single flight (range from the operator is limited to 1.86 mi due to control system transmission range). Recharge time for the main system Karma Battery is 1 hour and 2.5 hours for the Karma Controller. Maximum flight speed is approximately 35 mph and maximum operational altitude is 14,500 ft MSL. Maximum operational wind (wind resistance) is 22 mph.

Control and video streaming are performed over 2.4GHz Wi-Fi using a “clamshell” type remote with an integrated video and touch screen. The system has a maximum range of 1.86 mi (3 km) and does allow for dual control using the companies GoPro Passenger App.

The Karma system does not currently have automated tracking or obstacle avoidance capabilities. The system does not have the capability to use a smart phone for control.

Additional specification information can be found at, <https://shop.gopro.com/karmatechspecs>.

## 2.2 DJI Mavic Pro

The Mavic Pro drone platform has 24 high-performance computing cores, a 4-sensor vision system, GPS + GLONASS plus dual IMU and compass based positioning and navigation system, ultrasonic sensor based 3D mapping and collision avoidance system, precision landing system, and a 3-axis stabilized mechanical gimbal 4K video capture system based on a 1/2.3" CMOS sensor. Gimbal range of motion is -90 to +30 degrees as well as roll capability. All key sensors are redundant.

The system's 3,830 mAh LiPo based power pack is capable of providing somewhere between 25 and 30 minutes of flight time and a maximum travel distance of approximately 8 mi. during a single flight (range from the operator is limited to 4.3 mi). Maximum flight speed is approximately 40 mph, and maximum operational altitude of is 16,400 ft MSL. Maximum operational wind (wind resistance) is 24 mph.

Control can be performed from the handheld remote control or directly from a smart phone. The controller has an integrated LED display and expands to hold a smart phone which serves as a video and touch screen. The OcuSync control and video streaming system is based on DJI's proprietary 2.4 to 2.483GHz Lightbridge 2 technology<sup>1</sup>. It has a 4.3 mi (7 km) range capability and provides real-time full 1080p HD streaming video. Additionally, the DJI Goggle (separate accessory) can provide an immersive type of video feed viewing and "first person" flight control experience that allow the operator to control certain flight activities with head movements.

Coupled together, the vision sensors, ultrasonic sensors, 3D mapping capability, and DJI FlightAutonomy and ActiveTrack software allow the system to detect obstacles up to approximately 50ft away, perform automatic collision avoidance, and maintain continuous target track. The ActiveTrack software provides for multiple types of target tracking: Trace (follow in front, behind, or circle), Profile (fly alongside target), and Spotlight (keep camera on target while flying any route). Additionally, the system can be set to maintain a particular attitude above ground level as it follows a target. The system also recognizes hand gestures to take still pictures (this could be useful in the field, especially if recognition of additional hand gestures could be incorporated). Multiple control devices can be connected simultaneously.

Additional specification information can be found at, <http://www.dji.com/mavic/info>.

## 2.3 Systems Comparison

Table 1 provides a comparison of both systems. For relative size comparison, Figure 1 shows a side-by-side comparison of the drones and controllers and Figure 2 shows a side-by-side comparison of the system packs.

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<sup>1</sup> Compared to standard 2.4 and 5 GHz Wi-Fi type control systems, Lightbridge 2 offers significant advantages in terms of reduced dropouts, reduced latency and greater range. However, it is less capable than analog video transmission broadcasting which have almost no latency and ranges of 50+ miles. Amazon's 5 GHz CONNEX technology also offers near-zero latency, but with a range of only approximately 0.6 mi (1 km), it is even more limited in some respects than Wi-Fi control.

Table 1. Comparison of Karma and Mavic Pro Drone Specifications

Specification	GoPro Karma	DJI Mavic Pro
Built-in Camera	No	Yes
IMU & Compass	No	Yes (dual)
Vision Positioning System	No	Yes
Obstacle Sensing System	No	Yes (49 ft Ultrasonic Ranging / 3D Mapping)
Positioning System	GPS	GPS + GLONASS, IMU + Compass,
Precision Landing	No	Yes
Orbit	Yes	Yes
Object Tracking	No	Yes (multiple modes)
Terrain Following	No	Yes
Dual Operator	Yes (GoPro Passenger App)	No (multiple controller capable)
Controller Screen	Video Touchscreen	LED info display only
Smart Phone as Monitor	No	Yes (provides Touchscreen ctr'l)
Transmission Method	Wi-Fi	Lightbridge
Transmission Range (mi / km)	1.86 / 3.0	4.3 / 7.0
Operating Frequency (GHz)	2.4	2.4 to 2.483
Downlink Stream	720p HD	Up to 1080p FHD
Gimbal	3-Axis (-90° to +0° EL)	3-Axis (-90° to +30° EL)
Camera Sensor	1/2.3" CMOS	1/2.3" CMOS
Camera Lens	FOV 94° 17.2mm f/2.8	FOV 78.8° 28 mm f/2.2
Resolution: UHD	4K up to 30p / 2.7k 60p	4K / 2.7k up to 30p + C4K 24p
Resolution: FHD	1080 up to 120p	1080 up to 96p
Resolution: HD	720 up to 240p	720 up to 120p
LOG Profile	ProTune™	D-Log / D-Cinelike
Bitrate	60 Mb/s	60 Mb/s
Stills	12MP RAW + WDR	12MP DNG RAW + HDR
Burst shooting	3/5/10/30 fps	3/5/7 fps
Timelapse	0.5s–60s	10s–60s (assumed)
Max. Speed	35 mph (15.6 m/s)	40 mph (17.8 m/s)
Max. Distance (mi / km)	0.86 / 1	4.3 / 7
Max. Altitude (ft / km MSL)	14500 / 4.5	16400 / 5
Max. Wind Resistance (mph / m/s)	22 / 9.8	24 / 10.7
Battery (V / mAh)	14.8 / 5100	11.4 / 3830
Flight Time, approximate (min)	20	27
Operating Temp. (°F / °C)	Unknown	32 to 104 / 0 to 40
Weight (g / lb)	1006 / 2.22	743 / 1.64 (with gimbal cover)
Dimensions-open (in L / W / H)	11.9 / 16.2 / 4.6	Unknown
Dimensions-folded (in L / W / H)	14.4 / 8.8 / 3.5	7.8 / 3.3 / 3.2
Price (basic)	\$799 (no camera)	\$749 (no controller)
Price (complete)	\$1099 (with Session/Hero 5)	\$999 (with controller)
Battery Price	\$99.99	\$89.00

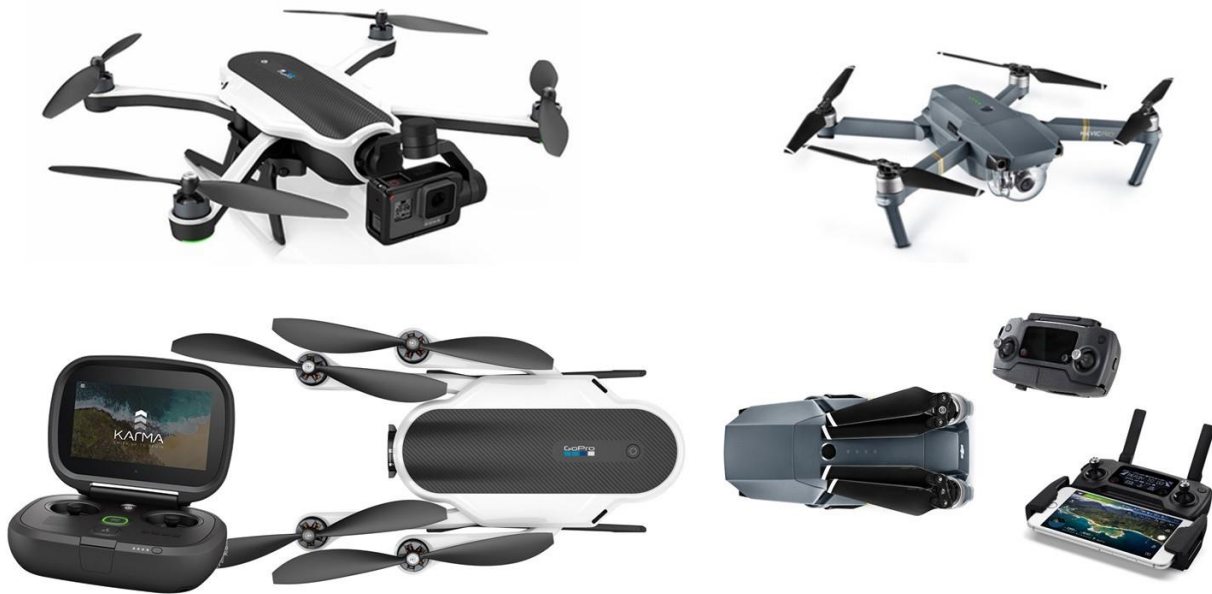


Figure 1. Drone Systems Comparison (Left – GoPro Karma, Right – DJI Mavic Pro)



Figure 2. Drone System Packs Comparison  
(Left – GoPro Karma, GoPro Case<sup>2</sup>, Right – DJI Mavic Pro, DroneGuard CS 200 Case<sup>3</sup>)

Note: the GoPro Karma system occupies the entire pack, while the DJI Mavic Pro system fits in the lower portion of the CS 200 case leaving room for additional storage in the pack top.

<sup>2</sup> GoPro.com, 2016

<sup>3</sup> LowePro.com, 2016